

***Persicaria geocarpica* Suyama & K. Ueda (Polygonaceae), sp. nov.,
and its Endemism and Subterranean Cleistogamy**

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A new species, *Persicaria geocarpica*, from central Honshu, Japan, is described. The plants are known from only a few sites in northeastern Aichi Prefecture nearby the type locality where they were first discovered. After detailed and intensive field studies, it became clear that the habitat of *P. geocarpica* is restricted to a particular mountainous area in the Tokai district. *Persicaria geocarpica* exhibits the unique characteristic that the inflorescences are elongated down to ground level at the end of the long flowering season. There are almost no morphological differences between terrestrial and subterranean flowers, but the latter can self-pollinate in the bud and mature underground without the floral parts expanding.

Key words: central Honshu, cleistogamy, Japan, new species, *Persicaria geocarpica*, Polygonaceae

In June, 1994, one of us (Suyama) discovered unidentifiable plants in Men-no-ki Park (Inabu, Toyota, Aichi Prefecture) that appeared to be closely related to *Persicaria debilis*, but evidently different. We reported these plants as a new taxon *Persicaria geocarpica* (Japanese name: Toyobotani-soba) during the 70th annual meeting of the Botanical Society of Japan (Suyama & Ueda 2006) and describe them here.

***Persicaria* (section *Echinocaulon*) *geocarpica* Suyama & K. Ueda, sp. nov.**—Fig. 1

Very similar to *P. debilis*, but easily identified by the stems with retrorse prickles and small, sparse stellate hairs; ocreae cylindrical, membranaceous; peduncle slender, bearing sparse, minute, recurved prickles; flowers 1 or 2 (or 3); often with subterranean cleistogamous flowers late in the season; stamens 5, ca. 1 mm long; nectaries 5, ca. 0.3–0.5 mm long.

Typus. JAPAN, Honshu: Aichi Prefecture, Toyota-shi, Inabu-cho (near Men-no-ki enchi park) [35°11'N,

137°34'E (WGS84)], 1110m alt., 18 Sept. 2005, C. Suyama., K. Ueda. & Y. Yoshida, SUYAMA2140 (holo-KANA [208659]; iso- K).

Herbs, annual, ascending or creeping, delicate, 10–30 cm tall. Stems 15–40 cm long, branched, ascending to decumbent, rooting at base; internodes 30–50 mm long, with retrorse prickles and small sparse stellate hairs. Leaves petiolate, alternate; petiole 15–25 mm long with antrorse prickles; lamina thin herbaceous, 20–40 mm long and wide, terminal leaves smaller, triangular hastate, base truncate to subcordate, apex acuminate, lower surface glaucescent, green, with dark purple V-shaped maculations, veins strigose, upper surface green, sparsely strigose. Ocreae 2–3 mm long, cylindrical, membranaceous, with short recurved prickles at base, apically bristly-ciliate (Fig. 2G, G'). Inflorescences terminal or axillary, solitary or clustered, pedunculate; peduncle slender, with sparse minute recurved prickles, pedicels ca. 0.5 mm long; 1 or 2 (or 3) flowered, terminated by a bracteole; subterranean inflorescences shorter, with an ocrea at each node (Fig. 2E); bract foliaceous, lanceolate

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FIG. 1. *Persicaria geocarpica* Suyama & K. Ueda.

to ovate, acuminate, reduced upward to a membranaceous ocrea. Bracteoles membranaceous, pale green or pale sanguineous, flower buds sheathed in bracteoles (Fig. 2A, A'); aerial chasmogamous flowers extrude from the bifurcated bracteole sheath; subterranean cleistogamous flowers often produced in late season, enclosed in bracteole, self pollinating (Fig. 2F). Pedicel sometimes bearing a small aborted bud at base. Flowers July to October, fruiting August to November. Perianth white, campanulate, 1.5–2 mm long, 5-parted to 2/3 its length, tepals elliptic, not accrescent in fruit. Stamens 5, white, ca. 1 mm long, epipetalous, alternate tepals (Fig. 2B); anthers introrse, adnate. Nectaries 5, white, spatulate, ca. 0.3–0.5 mm long, inserted between base of pistil and stamens, superposed to tepals (Fig. 2B). Style 1, white, ca. 1 mm long, 3-divided in upper 1/2, included, stigmas capitate (Fig. 2C). Achenes enclosed in perianth, trigonous, ovoid, ca. 3 mm long, smooth, lustrous brown (Fig. 2D, D').

Chromosome number. $2n = 18$ (Fig. 3)

Japanese name. Toyobo-Tanisoba (nov.).

The Japanese name, Toyobo-Tanisoba, refers to the beautiful tufted inflorescences.

Distribution. Japan, Honshu: Aichi, Gifu and Nagano Prefectures. Shaded moist places along streams and in open wet grasslands in mountainous areas (Fig. 4).

Other specimens examined. JAPAN, Honshu: Aichi Pref., Kitashitara-gun, Toyone-mura, *Tomiya*, C. Suyama 3078 (KANA[208660]), C. Suyama 3079 (KANA[208661]), C. Suyama 3080 (KANA[208662]); Higashikamo-gun, Asahi-cho, Tsubosaki, *Serizawa 63183* (herb. Serizawa). —Gifu Pref., Kamiyahagi, Mano, Itahoragawa, 18 Oct. 2008, K. Ueno & Y. Ueno s. n. (KANA[208048], KANA [208049]). —Nagano Pref., Shimoina-gun, Neba-mura, Hachimoriyama, C. Suyama 3087 (KANA[208091]).

The central area of the distribution of *Persicaria geocarpica* is from Men-no-ki in northeastern Aichi Prefecture to Chausu-yama, the highest mountain in Aichi Prefecture, then southwest to the Dando-san area, north to southwest Nagano Prefecture and Kamiyahagi-machi in Gifu Prefecture and east to northeast Aichi Prefecture and the southernmost district of Nagano Prefecture

(Fig. 4). No plants have been found in Shizuoka Prefecture.

Persicaria geocarpica is usually found in marshy places in headwaters of streams, on the tops of smooth, wide summits, or on the forest floor along streams flowing from marshes. *Persicaria geocarpica* grows with other herbaceous plants, such as *Nanocnide japonica*, *Oplismenus undulatifolius*, *Clinopodium micranthum* and *Mitella pauciflora*.

Persicaria geocarpica often grows sympatrically with the similar *P. debilis* and may be the reason that it has been overlooked until recently. No plants intermediate between them have been found.

The classification of Polygonaceae has been complicated due to extensive diversification (Park 1988, Kim & Donoghue 2008). Four tribes and eight genera are recognized in Japan: *Rumex* and *Oxyria* in Rumiceae, *Fagopyrum* in Fagopyreae, *Polygonum* and *Fallopia* in Polygoneae, *Bistorta*, *Aconogonon* and *Persicaria* in Persicarieae (Yonekura 2006). The genera *Polygonum*, *Fallopia*, *Bistorta*, *Aconogonon* and *Persicaria* are sometimes lumped with *Polygonum*, but we treat these groups as distinct genera as in many modern systems.

Within *Persicaria*, Haraldson (1978) recognized sections *Persicaria* (ca. 60 spp.), *Cephalophilon* (ca. 16 spp.), *Tovara* (ca. 3 spp.) and *Echinocaulon* (ca. 21 spp.). All four sections and 39 species have been reported from Japan (Yonekura 2006).

Persicaria geocarpica is classified into section *Echinocaulon* based on the ridged stems throughout, stems and petioles with retrorse prickles; ocrea neither 2-cleft nor lacerate; petiole not articulate; and filaments of stamens not dilated at base (Park 1988, Li *et al* 2003, Yonekura 2006).

Eleven species of section *Echinocaulon* are in Japan: *Persicaria perfoliata*, *P. senticosa*, *P. debilis*, *P. thunbergii*, *P. maackiana*, *P. praetermissa*, *P. hastatosagittata*, *P. muricata*, *P. breviochreata*, *P. dichotoma* and *P. sagittata* (Yonekura 2006). Several infraspecific taxa have been recognized within *P. thunbergii* s. l., some of which

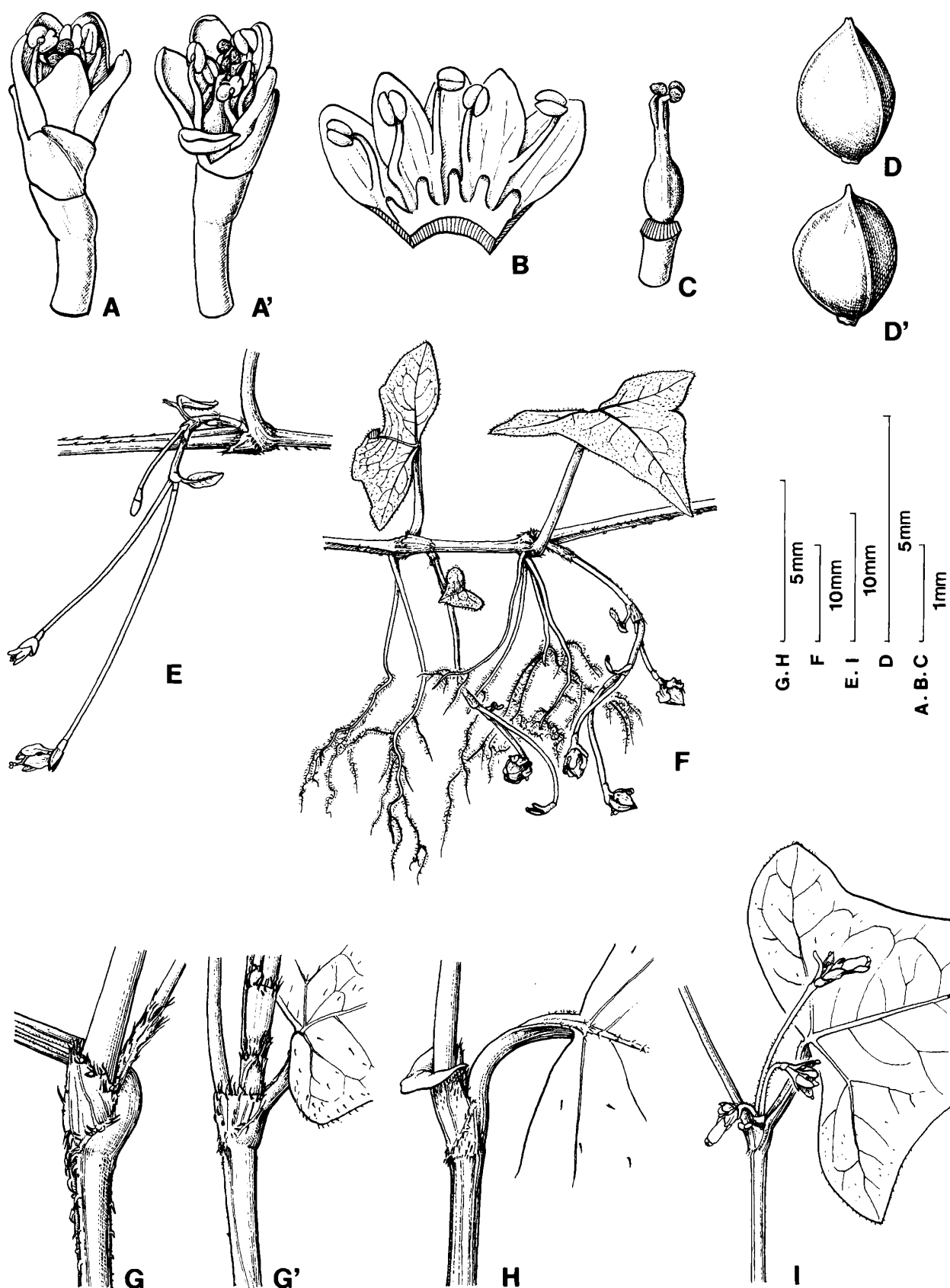


FIG. 2. *Persicaria geocarpica* Suyama & K. Ueda. A, A': Floret with bracteole. B: Inner surface of perianth. C: Pistil. D, D': Achene. E: Subterranean cleistogamous flowers. F: Subterranean fruits. G, G': Ocrea. H: Ocrea of *Persicaria debilis*. I: Inflorescences of *Persicaria debilis*.

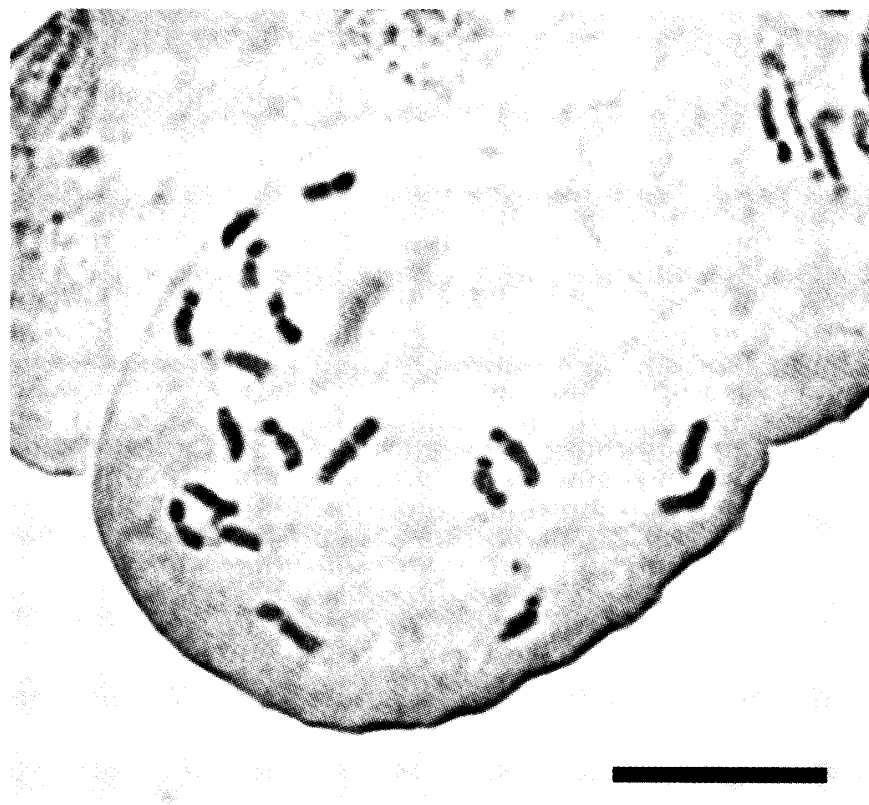


FIG. 3. Somatic chromosomes of *Persicaria geocarpica* ($2n = 18$). Bar = 10 μm . Chromosome number was counted in root tips from seven plants cultivated at Kanazawa University.

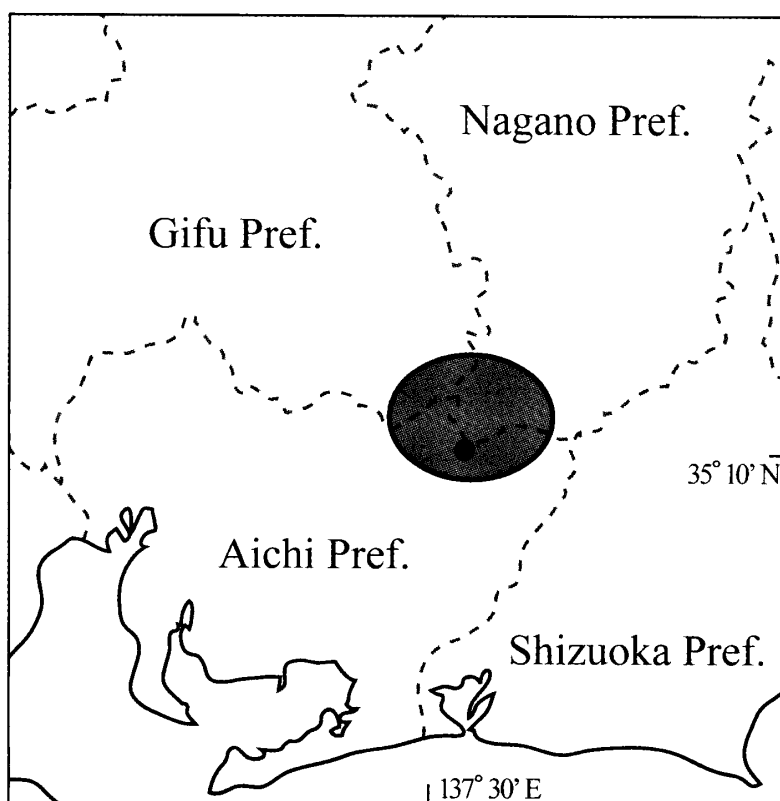


FIG. 4. Distribution of *Persicaria geocarpica*. ●: Type locality. ○: Additional localities. 1: Gifu Prefecture, Ena-shi, Kamiyahagi, Mano, Itahoragawa. 2: Aichi Prefecture, Higashikamo-gun, Asahi-cho, Tsubosaki. 3: Aichi Prefecture, Kitashitara-gun, Toyone-mura, Tomiyama.

have been proposed at specific rank (Hanai & Serizawa 2008). Additional species are known from other parts of the world (Sanchez *et al.* 2011).

Persicaria geocarpica is similar to *Persicaria*

debilis (Meisn.) H. Gross ex W. T. Lee at sight. But can be recognized as distinct on the basis of several unique morphological characteristics as listed below.

Key to the Japanese species of *Persicaria* Mill.

- 1a. Stems prickless (excl. *P. bungeana* : with scattered prickles on stem) **Sections *Persicaria*, *Cephalophilon*, *Tovara***
- 1b. Stems sparsely to densely prickly along ridges (**Section *Echinocaulon***) 2
- 2a. Flowers 3–5 mm long; inflorescences with many flowers (or 1 or 2 flowers in axils); flowers opening simultaneously 3
- 2b. Flowers 1.5–2 mm long; inflorescences with 1-several flowers terminal on peduncle; flowers opening successively 4
- 3a. Inflorescences compound racemes *P. muricata*, *P. preatermissa*, *P. breviochreata*
- 3b. Inflorescences capitate, condensed short racemes, or flowers 1 or 2 in axils
... *P. perfoliata*, *P. senticosa*, *P. thunbergii* s.l., *P. maackiana*, *P. hastatosagittata*, *P. dichotoma* *P. sagittata*
- 4a. Flowers several in condensed racemes (Fig. 2I); peduncles clustered in leaf axils; apex of ocreae with small dilated leaf-like limb (Fig. 2H); bracteoles herbaceous, green to pale green; stamens and nectaries 6–8
..... *P. debilis*
- 4b. Flowers 1 or 2(or 3), short pedicellate on long peduncle; apex of ocreae bristly-ciliate; bracteoles membranaceous, pale green to pale sanguineous; stamens and nectaries 5 *P. geocarpica*

Cleistogamy

Cleistogamy occurs in up to 700 species in 50 families of angiosperms (Culley & Klooster 2007). In most cases, there are clear morphological differences, called, dimorphic cleistogamy, between cleistogamous (CL) and chasmogamous (CH) flowers in Fabaceae, Violaceae, Lamiaceae and Balsaminaceae. In Polygonaceae, some populations of *Persicaria thunbergii* s. l. [section *Echinocaulon*] have been reported to produce dimorphic CL flowers (Hiratsuka 1984). The CL flowers are formed only in axillary inflorescences on the lower stem and the fruit are underground or at ground level. Three species of *Polygonum* s.l. were reported by Culley & Klooster (2007) to bear induced CL flowers, and one species was reported to produce dimorphic CL flowers.

A remarkable characteristic of *Persicaria geocarpica* is that the CL flowers are produced in two different positions of the inflorescences late in the flowering season.

The seeds of *Persicaria geocarpica* germinate in the spring. The solitary or clustered pe-

dunculate terminal or axillary inflorescences appear at the beginning of July and bear one, two, or rarely three shortly pedicellate CH flower(s) on each peduncle. The CH flowers usually last for 3 or 4 days.

In the late flowering season, from mid September to October, some rather short stout axillary peduncles are produced at the base of the stem and develop CL flowers near ground level. At the same time, the terminals inflorescences bend down into the wet soil and also form CL flowers as the plants become decumbent by the extension of lateral branches (Fig. 5). We did not find any morphological difference between the CL and CH flowers in *Persicaria geocarpica*. We consider the situation in *P. geocarpica* to be induced cleistogamy (Culley & Klooster 2007) where certain flower are changed from CH to CL depending on environmental conditions.

Even though the perianth of the CL flowers is enclosed by the bracts, the pollen of the unopened flowers has already attached to the stigma. Fruiting set in CL flowers appears to be high.

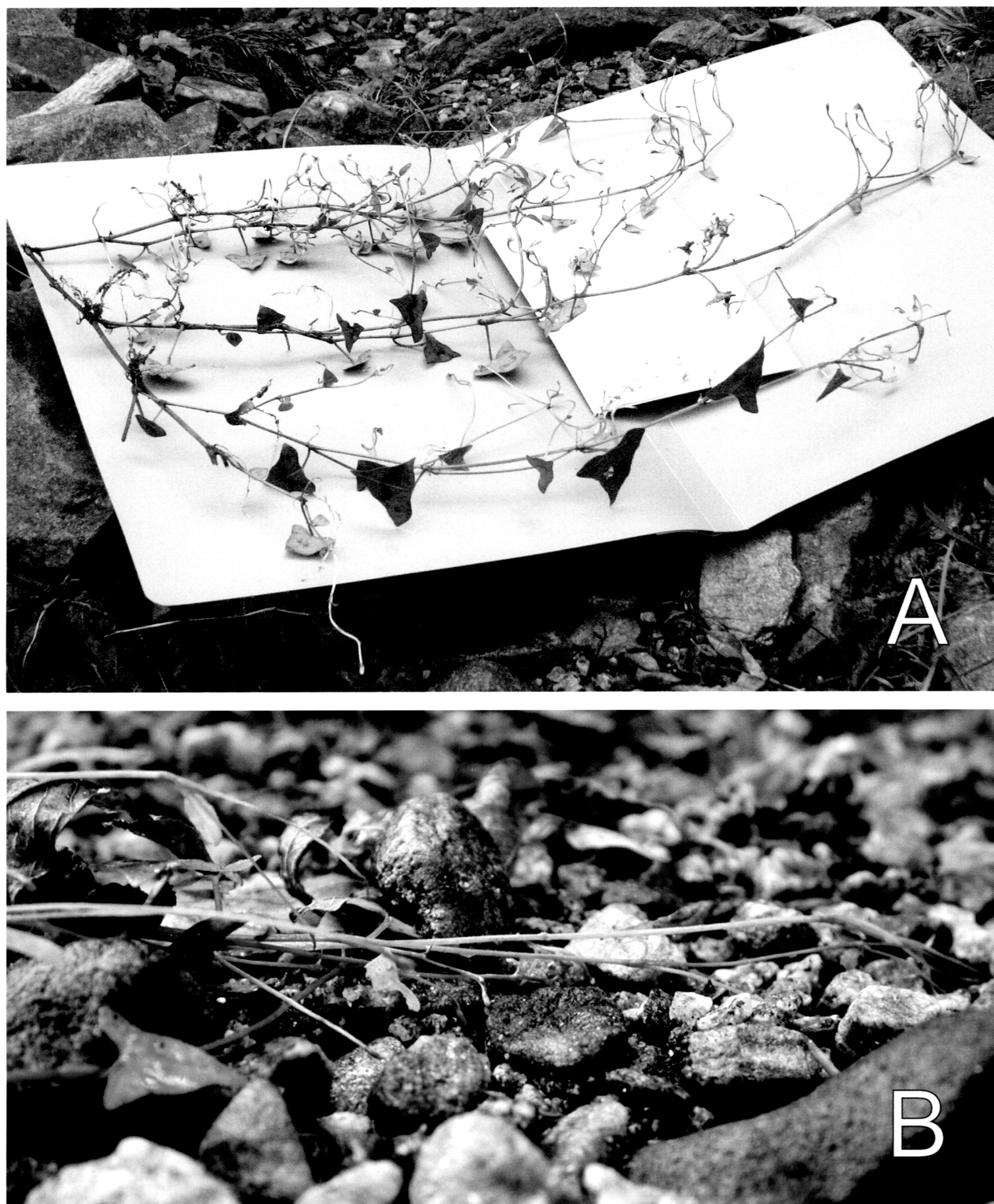


FIG. 5. *Persicaria geocarpica* in autumn. Photographs taken on 5 October, 2008. A: Upper portion of plant lying on ground (Suyama 3079, KANA[208661]). B: Terminal and axillary inflorescences becoming decumbent during late season flowering.

We thank Mr Y. Yoshida for thoughtful collaboration, and Mr M. Umebayashi for preparing the illustrations. We are indebted to the curators of KYO, SHIN, TI, TNS, Horai-jisan Natural History Museum and Toyohashi Museum of Natural History for allowing us to study their specimens. Our gratitude is also extended to the members of the Toyohashi Botanist Club for their fellowship in field observations.

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Received October 26, 2011; accepted September 13, 2012